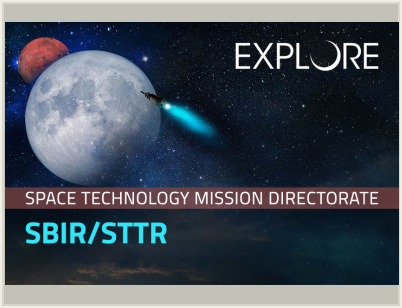
Physical Modeling for Anomaly Diagnostics and Prognostics, Phase II

Completed Technology Project (2011 - 2013)

Project Introduction

Ridgetop developed an innovative, model-driven anomaly diagnostic and fault characterization system for electromechanical actuator (EMA) systems to mitigate catastrophic failures. Ridgetop developed a MIL-STD-1553 bus monitor and a MIL-STD-1553 bus controller that simulates the aircraft data bus, reads the environmental (i.e., altitude) and operational (i.e., response of system) data of a system and determines if a fault is manifesting; and if true determines the root cause and symptoms of the fault. Once an anomaly is detected, the Model-based Avionic Prognostic Reasoner (MAPR) solves a user-outlined state-space model, symbolically, using a Gauss-Newton optimization method and the information from the MIL-STD-1553 bus. This algorithm outputs a list of best fitting parameters to match the command to the actual performance. Rules are programmed in, based on results from principal component analysis . The rules determine both fault mode and the severity of that fault. The rules can distinguish between two failure modes: Mechanical jam and MOSFET failure, and healthy. The real-time processing will allow for critical evolutions in flight safety and provides a game-changing approach to condition-based maintenance. Once deployed, flight safety can be improved by allowing the on-board flight computers to read from the MAPR and update their control envelope based on its evaluations, reducing damage propagation and increasing operational safety. In Phase 2, we will develop a functioning ground-based prototype of the technology to show the efficacy of the method. A ground-based version of the tool is the best candidate for development to ease adoption by testing in a low-risk environment; this tool will be demonstrated at the end of Phase 2. The MAPR concept is also applicable to any system with a state-space representation but at this point it has been developed with EMAs in mind. The MAPR prototype is at TRL 5 and will reach a TRL 7 by the end of Phase 2.



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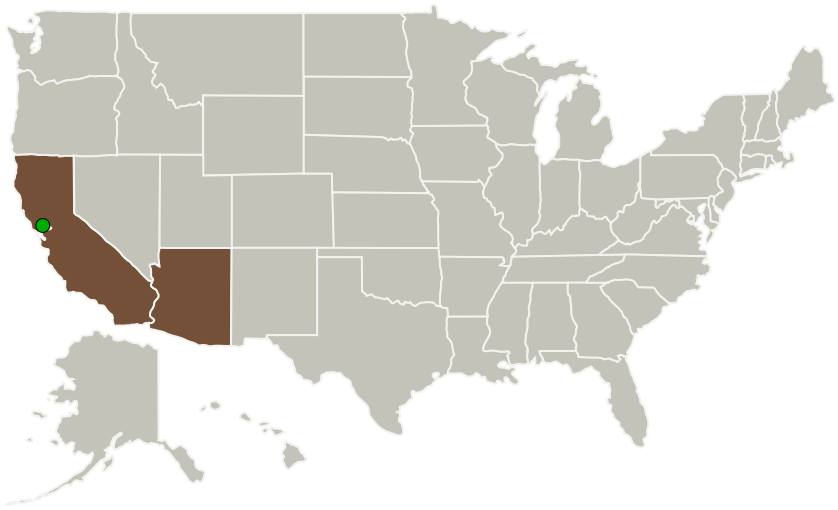
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Ridgetop Group, Inc.	Lead Organization	Industry Women-Owned Small Business (WOSB)	Tucson, Arizona
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations	
Arizona	California

Project Transitions

June 2011: Project Start

May 2013: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/139333)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Ridgetop Group, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

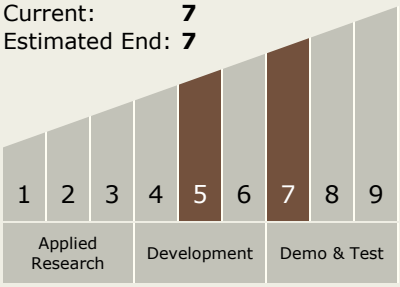
Carlos Torrez

Principal Investigator:

Neil Kunst

Technology Maturity (TRL)

Start: **5**
Current: **7**
Estimated End: **7**



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Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.5 Mission Architecture, Systems Analysis and Concept Development
    - TX11.5.2 Tools and Methodologies for Performing Systems Analysis

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System